Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals **26 November 2013**

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Classification criteria and hazard communication: Dust explosion hazards

Dust explosion hazards: Workstream 3 proposal

Transmitted by the experts from the United States of America, Canada and Australia

I. Introduction

1. The work proposed by the dust explosion hazards correspondence group on Workstream 1 was adopted by the Sub-committee during the 24th session.

2. This paper provides background on the concerns of dust hazards, summarizes work done to date, and provides a proposed path forward for Workstream 3: "to start the discussion and develop an outline or work plan for guidance or a separate chapter in the GHS containing more detailed information on the conditions under which a dust explosion hazard could be encountered."

II. Background

3. Dust explosion hazards involve dusts or other small particles that present a fire or deflagration hazard when suspended at a sufficient concentration in air or some other oxidizing medium. Where such materials are contained in an enclosure, they present an explosion hazard.

4. A small dust explosion can stir up dust that has settled on surfaces nearby, which in turn ignites, creating a larger explosion, which in turn forces more dust in the air. This series of cascading secondary explosions are generally more hazardous than the initial one, and can lead to many deaths, injuries, and substantial facility damage.

5. Not all materials present this hazard, even when reduced to fine particles. For example, silicates, sulphates, nitrates, carbonates, phosphates, cement, salt, gypsum, sand, and limestone do not present fire or deflagration hazards.

6. However, many materials do present dust explosion hazards. Many organic materials, plastics, and metals are explosible in dust form.

7. Studies show explosible dust is a significant hazard across the world. A 2006 study by the United States of America Chemical Safety and Hazard Investigation Board (CSB) identifies 281 combustible dust incidents between 1980 and 2005 in U.S. workplaces in

which 119 workers had been killed, 718 workers had been injured, and industrial facilities had been extensively damaged. [1] A paper by Abbasi and Abbasi collects various studies of dust explosions, including one showing 269 incidents in Japan between 1952 and 1995 that killed 109 and injured 567, and another showing 159 dust explosions in the United Kingdom between 1979 and 1988, 36 of which caused injury.[2] Yan and Yu report 72 incidents in China between 1981 and 2011 that claimed 123 lives and injured 518, including one incident in which 58 people died and 177 were injured.[3]

8. Though many dust explosion hazards are created in the workplace due to the way materials are processed, other materials present the hazard in the form that they are shipped. An example is the dust explosion incident that occurred at the CTA Acoustics facility in Corbin, Kentucky on February 20, 2003. The CSB found that a series of explosions were caused at the plant by phenolic resin dust used in the manufacturing process.[4] The initial explosion was caused when workers engaged in cleaning operations that created a cloud of resin dust which ignited. The force of this explosion shook loose resin dust that had accumulated on overhead roof joists. This dust in turn ignited, creating secondary explosions throughout the facility. Seven employees were killed and 37 were injured. A similar material produced by the same manufacturer was involved in an explosion on February 25, 1999 at the Jahn Foundry in Springfield, Massachusetts.

9. After an investigation, the CSB found that most CTA Acoustics employees had an inadequate knowledge of the resin dust's explosion hazard and that the dust's material safety data sheet (MSDS) did not adequately communicate the fact that the material posed a dust explosion hazard.

10. As a part of its 2006 Combustible Dust Study, the CSB reviewed the MSDSs of 140 known combustible dusts to determine whether inadequate dust hazard communication is widespread. Only 59 percent made any notation of the explosion hazard, only seven listed the appropriate industry standard for managing combustible dust hazards, and none listed the physical properties of the dust or explained why dusty conditions should be avoided (i.e., to avoid creating the potential secondary explosions).

11. Since it was initially adopted, the GHS has required listing other hazards which do not result in classification, including dust explosion hazards, in section 2 of the safety data sheet (SDS). (Table 1.5.2) Among its suggestions, the CSB recommended that the GHS be amended

(a) to adopt a definition of explosible dusts;

(b) to specify the hazards to be addressed on SDSs; and

(c) to address the physical properties of combustible dusts that should be included on the SDS.

[1] U.S. Chemical Safety and Hazard Investigation Board, Investigation Report: Combustible Dust Hazard Study (2006). (http://www.csb.gov/investigations/detail.aspx?SID=24&Type=2&pg=1&F_InvestigationId=24 last accessed Mar. 13, 2013)

[2] Abbasi, T. and Abbasi, S.A., Review: Dust explosions—Cases, Causes, Consequences, and Control, J. Haz. Mat. 140 (2007) 7-14.

[3] Yan, X. and Yu, J., Dust Explosion Incidents in China, Process Safety Prog. 31 (2012) 187-89.

[4] U.S. Chemical Safety and Hazard Investigation Board, Investigation Report: Combustible Dust Fire and Explosions, CTA Acoustics, Inc. (2005) (http://www.csb.gov/investigations/detail.aspx?SID=35&Type=2&pg=1&F_InvestigationId=35 last accessed Mar. 13, 2013).

III. Sub-committee's activities concerning dust explosion hazards

12. As adopted by the 24th Session of the Sub-Committee, there are currently three workstreams on explosible dust:

(a) Workstream 1: review the existing national consensus and reference regulations developed by competent authorities, identify the common pieces of information used to communicate the hazards, and determine how and if this information is to be addressed;

(b) Workstream 2: ensure that any information proposed to be included in section 9 of the SDS is communicated to the working group on Section 9 of Annex 4;

(c) Workstream 3: start the discussion and develop an outline or work plan for guidance or a separate chapter in the GHS containing more detailed information on the conditions under which a dust explosion hazard could be encountered.

13. The history of the activities of the Sub-Committee and the correspondence group on dust explosion hazards are summarized in Annex I. As a part of Workstream 1, the correspondence group conducted a survey among Sub-Committee members and Non-Governmental Organizations (NGOs) on definitions, tests, and hazard communication techniques for explosible dusts. A summary of the results of the survey are attached as annexes II and III. The survey was completed in the 2009-2010 biennium. Since that time, the United States has updated its regulatory scheme to align with the GHS, and Canada has proposed to do the same. Therefore, the survey response summary has been updated (in track-changes) to reflect the changes from these two countries. Other implementing countries are invited to provide any additional survey updates to the correspondence group Chair.

IV. Discussion

14. There is substantial evidence that many, but not all, materials shipped in dust form present a serious hazard in downstream workplaces. If employers and workers do not know about the hazard, they might engage in operations, such as improper cleaning techniques, that generate clouds of the dust that could ignite. In addition, without knowledge of the hazard, employers and workers might allow these dusts to accumulate, creating the potential for devastating secondary explosions. Indeed, the CTA Acoustics case is a documented instance in which this occurred.

15. The CSB study shows that the dust explosion hazards of products are not being adequately communicated by manufacturers. A substantial percentage (41%) of MSDSs it reviewed made no note of the hazard at all, and all of the MSDSs it reviewed failed in some way to convey adequate information about the hazard. A number of respondents to the correspondence group survey also reported that SDSs do not adequately communicate dust explosion hazards.

16. One reason for this failure is the lack of a uniform, harmonized definition and criteria for [explosible dust to aid classifiers in determining whether their product presents the hazard. The correspondence group's survey showed that there are a wide variety of properties, tests, and test apparatus that may be used to characterize an explosible dust.

17. Nonetheless, review of the survey responses show that there are commonalities that might be built upon to achieve a harmonized classification:

(a) Though particular linguistic formulations vary somewhat from source to source, many use a qualitative definition which covers fine dusts that when dispersed in air and ignited pose a fire, deflagration, or (if enclosed) explosion hazard.

(b) Many sources agree that dusts of combustible materials containing a sufficient concentration of particles of a size less than 500 µm should be treated as an explosible dust.

(c) There are several test methods used to determine the explosibility of dust, including ISO 6184, ASTM 1226 and EN 14034.

(d) There is published data on the explosibility characteristics of various dusts that might, in some circumstances, be used to determine whether particular dusts pose an explosibility hazards.

V. Proposal

18. As evidenced in the survey responses, many countries are already addressing dust explosion hazards in various ways. It is appropriate that a harmonized approach to classification and communication of dust explosion hazards be developed. We propose that a chapter be developed, titled, "Explosible Dusts", and include a definition, classification criteria, hazard communication elements, and other guidance determined to be necessary.

19. In addition, recalling previous discussions in the Sub-committee on nanomaterials and Annex 4, the dust explosion hazards correspondence group proposes to discuss explosible dust hazards with the correspondence groups addressing nanomaterials and Annex 4 to determine how they might be addressed in these activities, as appropriate.

20. The dust explosion hazards' correspondence group will discuss this information and whether it provides a way forward on Workstream 3 in a plenary session at the upcoming 26th Session of the Sub-Committee. All interested members and observers are invited to attend and participate. The agenda for the meeting is as follows:

(a) Review status of each Workstream;

(b) Review proposal contained in this informal paper;

(c) Other related items;

Annex I

History of the sub-committee's activities on dust explosion hazards

1. On consideration of a working paper on the matter from the expert for the United States (ST/SG/AC.10/C.4/2009/6), the Sub-Committee, at its 17th session, entrusted the consideration of the issue to a correspondence group on dust explosion hazards led by the United States. The correspondence group was charged with conducting a survey of members of the Sub-committee on their existing practices and regulations for addressing dust explosion hazards in workplaces. The correspondence group was directed to analyse the information collected and develop recommendations for the Sub-Committee to address dust explosion hazards (refer to the report of the Sub-Committee on its 17th session, document ST/SG/AC.10/C.4/34, paras. 9–13). The terms of reference may be found in INF.22/Rev.1 (17th session).

2. The correspondence group developed a questionnaire asking for information on definitions, tests, and hazard communication techniques used for dust explosion hazards (ST/SG/AC.10/C.4/2010/8). It received responses from nine members of the Sub-Committee and four industries or industry representatives. The responses are summarized in annexes II and III.

3. After considering the responses and discussing potential ways forward, the correspondence group proposed and the Sub-Committee adopted, at its 22nd session, three workstreams:

(a) Workstream 1: review the existing national consensus and reference regulations developed by competent authorities, identify the common pieces of information used to communicate the hazards, and determine how and if this information is to be addressed;

(b) Workstream 2: ensure that any information proposed to be included in section 9 of the SDS is communicated to the working group on Section 9 of Annex 4;

(c) Workstream 3: start the discussion and develop an outline or work plan for a separate chapter in the GHS containing more detailed information on the conditions under which a dust explosion hazard could be encountered.

(See the report of the Sub-Committee on its 22nd session, document ST/SG/AC.10/C.4/44, para.15; additional details may be found in INF.12 (21st session) and INF.21(23rd session))

4. Over the next two sessions of the Sub-Committee, the correspondence group considered changes to Annex 4 of the GHS in order to provide additional guidance for information about dust explosion hazards on SDSs. The Sub- Committee agreed to the following changes to Annex 4 at its 24th session:

(a) For Section 2 of the SDS (Hazard identification):

Amend A4.3.2.3 "Other hazards which do not result in classification" to read as follows (new text is underlined):

"Provide information on other hazards which do not result in classification but may contribute to the overall hazards of the material, for example, formation of air contaminants during hardening or processing, dust explosion hazards, suffocation, freezing or environmental effects such as hazards to soil- dwelling organisms. The statement "May form explosible dust-air mixture if dispersed" is appropriate in the case of a dust explosion hazard."

(b) For Section 5 of the SDS (Fire-fighting measures):

Amend A4.3.5.1 "Suitable extinguishing media" to read as follows (new text is underlined):

"Provide information on the appropriate extinguishing media. In addition, indicate whether any extinguishing media are inappropriate for a particular situation involving the substance or mixture (e.g., avoid high pressure media which could cause the formation of a potentially explosible dust-air mixture)."

(c) For Section 7 of the SDS (Handling and storage):

Amend A4.3.7.1.1 to read as follows (new text is underlined):

"Provide advice that:

(a) allows safe handling of the substance or mixture;
(b) prevents handling of incompatible substances or mixtures;
(c) draws attention to operations and conditions which create new risks by altering the properties of the substance or mixture, and to appropriate countermeasures; and
(d) minimizes the release of the substance or mixture to the environment."

(See the report of the Sub-Committee on its 24th session, document ST/SG/AC.10/C.4/48, para.32,)

5. In addition, the 23rd Session of the Sub-Committee asked the correspondence to consider whether the term "explosive dust" was better suited than "explosible dust" as a name for the hazard (see report of the Sub-Committee on its 23rd session, document ST/SG/AC.10/C.4/46 paragraph 18) . The correspondence group addressed this issue in document ST/SG/AC.10/C.4/2012/28 where it reported that explosives are distinct materials whose main purpose is to function by explosion. Dust explosion hazards, by contrast, occur when explosible dusts are dispersed in air under certain conditions. The hazards and controls for the materials are different, and therefore "explosible dust" was the correct term for purposes of hazard communication.

6. At its 24th session, the Sub-Committee noted that the correspondence group had nearly completed its work on Workstream 1, intended to continue cooperation with the Annex 4, Section 9 correspondence group, and that work had not yet begun on Workstream3. The Sub-Committee endorsed the programme of work for 2013-2014 proposed by the group (i.e. further work on Workstreams 1, 2, and 3, amending Workstream 3 to allow the correspondence group to consider developing additional guidance instead of a separate chapter in the GHS for explosible dust) (see the report of the Sub-Committee on its 24th session, document ST/SG/AC.10/C.4/48 para.71; Additional details may be found in INF.37 (24th session)

Annex II

Survey responses submitted on the dust explosion hazard survey by the GHS Sub-Committee government experts during the 2009-2010 biennium

(Updates provided by Canada and the United States in 2013 are presented in track-changes)

A. Definition

1. How should explosible dust be defined - by minimum particle size, without regard for particle size, or should the definition vary for the type of dust?

Response	*Country*
INTRODUCTION Finding out if a dust is explosive or not is easy to do, based upon existing historical data or lab testing. Tests can determine a dust's ease of ignition, upper and lower explosive limits and explosion severity. The actual severity of a dust explosion in say a silo will depend very much upon the environmental circumstances in the particular instance, such as moisture content, confinement, turbulence, dust concentration and the failure pressure of the silo. However, the biggest issue to deal with is a very basic workplace awareness of the risk of such explosions when explosive dusts are handled, stored or processed. *Definition of an explosible dust* An explosible dust is a finely divided flammable solid that when dispersed in air, confined, and ignited burns so rapidly that there is an increase in pressure. (Pyrotechnic materials should be excluded from this definition.) ***Minimum Particle Size*** The explosion properties of a dust are strongly dependant upon the dust's chemistry and its particle size. So a dust's particle size may be a useful way to discriminate between a solid fuel such as wood chips that will burn slowly, and sawdust that when in the form of a dust cloud can burn explosively. Some dusts are always a risk because they are in the form of a fine flammable solid (e.g. wheat flour). Other coarser solid fuels may only be a risk if fines are present or if these are generated during handling, usage or allowed to concentrate by accumulation for instance. About 500µm seems to be the top size referred to as dust particles. Particles greater than this will not stay in suspension for any appreciable period of time. Therefore for the majority of explosive dusts, they will not present a dust explosion hazard if the particle size is greater than 500µm. A simple classification and labeling scheme should as a first requirement communicate the presence of a risk in a simple way and not go into detail about how easily and how explosive the dust is. Such a scheme would simply alert that the material can be a dust explosion hazard if the particle size is less than a stated minimum particle size. This approach leads to a cautionary labeling scheme: (1) For dusts that are always sufficiently fine that a potential hazard exists whenever it is handled; a simple caution statement like the following may be appropriate: POTENTIALLY EXPLOSIVE DUST, ***or***	Australia

Response	*Country*
(2) For dusts that are usually too coarse (greater than 500µm) to be an immediate dust explosion hazard, but may contain fines or can produce fine particles during handling; a simple caution statement like the following may be appropriate: ***EXPLOSIVE DUST HAZARD FOR PARTICLES LESS THAN 500µm***	
~~Proposed Classification Criteria and Labelling Elements for Explosible Dust in the Canadian Workplace Hazardous Materials Information System (WHMIS)~~ ~~Definition: Explosible dust is defined as any dust which presents a fire or explosion hazard when dispersed or ignited in air~~. Currently, there is no definition or criteria for explosible or combustible dusts in the federal *Hazardous Products Act* or the *Controlled Products Regulations*. As part of the initiative to implement the GHS for workplace chemicals in Canada, a new hazard class for Combustible Dusts is proposed to be added to the Canadian Workplace Hazardous Materials Information System (WHMIS). The proposed definition for combustible dust is the following: "Combustible dust" means a mixture or substance that is in the form of a powder that is liable to catch fire or explode when dispersed in a gas containing oxygen.	Canada
In our opinion, besides the kind of dust, the explosion characteristics of dust also depends on the particle size, moisture content and the shape of dust. In fact, the possibility of dust explosion increases with the decreasing of particle size and moisture content. So, in the test, the particle size and moisture content should be included. In the definition, if possible, a maximum particle size that can result a destructive explosion or inflammation may be defined.	China
For dusts which are explosible we use in Germany the name "Staubexplosionsfähigkeit" which can be translated as "dust explosibility". A dust is dust explosible if a dust/air mixture of the particular dust can be ignited with an ignition source with a defined energy resulting in a self propagating flame, which in a closed vessel leads to a pressure increase. To find out if a dust is explosible it has to be tested. This test in done according the VDI-guideline 2263 part 1 in one of the test equipment 1 m^3- vessel, 20-l-vessel or modified Hartmann tube. An explanation which dusts can be explosible is more complicated and does not depend from particle size and type of dust only. Experience shows that particles > 500 µm are not dust explosible. But if such a bulk contains smaller particle which are able to explode the coarser material can react as well. In the field of dust explosions in Germany with "dust" particles are meant which are finer than 500 µm. A criterion which has to be fulfilled that he might be explosible is that the dust must at least be exothermally oxidizable. However, not all exothermally oxidizeable dusts < 500 µm are explosible. As a trend the finer the dusts are the higher is the propability that they are explosible. But it exists no exact boundary value between explosible and non explosible. For a safe prediction the dust has to be tested. Especially mixtures of combustible and inert materials (e.g. mineral dust or metal oxids) should be tested. There is a wide spectrum of dust types which can be explosible. But the type of dust alone is not sufficient for the criteria. Tests on explosibility of the same dust type (sometimes with the same name) and comparable particle size distribution show that some dusts are explosible whereas others are not. Hence, information about dust type and particle size is in many cases insufficient to guarantee whether a dust is explosible or not.	Germany

Response	*Country*
As a starting point I believe it should be defined by its explosive properties. From my experience as a regulator in Ireland there is very little knowledge outside the PharmaChem Industries in the area of dust explosion. Unlike flammable liquids/gases, a combustible dust is not explosive unless the particle size is capable of propagating a flame, and it is dispersed to the right concentration (in a process) where there is an energy source. I believe one other member of our group stated that it is not appropriate to define corn flour as dangerous and to label it as hazardous. From my experience in the Pharmaceutical Industry, most if not all active ingredients are combustible. In a sealed drum on a warehouse floor they pose no risk of a dust explosion. Put the material into an air jet mill and there exists a very real risk of a dust explosion. In the case of a flammable liquid/gas, it is labelled accordingly. In the case of a dust you can really only label the mixture of the dust and the process with the caveat that the dust must have a particle size capable of propagating a flame (not to mention moisture content). The Department of Labor paper supplied refers to a "fire pentagon". This concept summaries very well what I am trying to say.	Ireland
Per *Directive 1999/92/EC 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres* For the purposes of this Directive, 'explosive atmosphere' means a mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture. Flammable and/or combustible substances are considered as materials which may form an explosive atmosphere unless an investigation of their properties has shown that in mixtures with air they are incapable of independently propagating an explosion. *Zone 20* A place in which an explosive atmosphere in the form of a cloud of combustable dust in air is present continously, or for long periods or frequently. *Zone 21* A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally. *Zone 22* A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only. Per *Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres* *Explosive atmospheres* Mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture. *Potentially explosive atmosphere* An atmosphere which could become explosive due to local and operational conditions.	Netherlands
Not answered	South Africa

Response	*Country*
Explosive dust atmosphere is defined as a mixture with air under atmospheric conditions, of flammable substances in the form of dust or fibres in which, after ignition, combustion spreads throughout the unconsumed mixture (see BS EN 13237). For a dust explosion to take place a number of conditions must be satisfied simultaneously(Barton 2002): (a) The dust must be explosible and have a particle size that will allow the propagation of flame. (b) The atmosphere into which the dust is dispersed as a cloud or suspension must contain sufficient oxidant to support combustion. (c) The dust cloud must have a concentration within the explosible range. (d) The dust cloud must be in contact with an ignition source of sufficient energy to cause ignition.	UK
The Hazard Communication Standard, aligned with the GHS and published in March 2012, uses the operative definition in ~~At present OSHA has taken a position in its~~ OSHA's Combustible Dust National Emphasis Program to define "Combustible Dust" as any combustible particulate solid ~~material~~ that presents a fire or deflagration hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape. This definition is based on the National Fire Protection Association (NFPA) 654's definition. A "combustible particulate solid," in turn, is defined as any combustible solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition. Having a particular particle size included in the definition may cause confusion with respect to what percent of a defined size should be present in the dust before it can be considered to be combustible dust. OSHA is currently engaged in developing a rule to address combustible dust hazards, and as a part of that effort will be examining combustible dust definitions further.	USA

2. Do you determine whether a dust is considered explosible by reference to published data, testing, safety data sheets (SDSs), or some other means? Please explain.

Response	*Country*
In Australia private engineering consultants generally provide dust explosion risk assessment services to industry. These consultants do not have the facilities to undertake dust explosion testing. These consultants often advise their clients to have their samples tested to determine if their dust is explosive and/or to determine the dust explosion indices. They may also rely upon historical data or industry information. Speaking from a government owned laboratory point of view, it is best to prove/disprove that a dust can be explosible by practical tests. Published data or industry experience should be regarded only as an indication of a potential risk. We determine if a dust is explosive by testing a fine dry sample of dust according to the ISO or ASTM methods or other suitable methods shown to be equivalent. The general consensus with safety data sheets is that they are unreliable for this particular type of data.	Australia

Response	*Country*
~~Proposed Classification Criteria and Labelling Elements for Explosible Dust in the Canadian Workplace Hazardous Materials Information System (WHMIS)~~ ~~Classification Criteria:~~ ~~(1) Any dust which~~ ~~a. When tested in accordance with an acceptable test method has been shown to be explosible; or~~ ~~b. Has been demonstrated to be explosible when used in the workplace is classified in Category 1 – Explosible Dusts.~~ ~~(2) Any mixture which is combustible and has 5% or more of its composition (by weight) having a particle size of 420µm or less is classified in Category 1 – Explosible Dusts.~~ Proposed Classification Criteria for Combustible Dusts in the Canadian Workplace Hazardous Materials Information System (WHMIS): A mixture or substance that: (*a*) has been shown to catch fire or explode when dispersed in a gas containing oxygen; or (*b*) is classified in a division of the hazard class "Flammable Solids" and 5% or more of its composition by weight has a particle size ≤ 500µm	Canada
We determine if a dust is explosible mainly refer to the test data, then SDSs, and then published data. At present, most of SDSs and published reference have not supply the relative data of particle size and moisture content. Even if the same kind of dust, for example, aluminium dust, the explosion characteristics is varied from the different particle size and moisture content. So, the data of dust explosion should include the relative data of particle size and moisture content, in this condition, the data may be applied to the industry.	China
As a first orientation databases such as the GESTIS-DUST-EX-Database of the IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance) can give information on explosiblility for a particular dust (see http://www.dguv.de/ifa/en/gestis/expl/index.jsp). But due to the influencing parameters discussed in 1. the values should only be used for orientation and the limits of applicability have to be considered. For placing on the market, in addition tests according to VDI 2263-1 have to be carried out in order to determine whether a dust is explosible or not. The decision whether testing is actually necessary or not should take into account whether particles with a size < 500µm are present, see answer to question 1 above. This information should be given in the SDS. If no tests are carried out (based on the actual particle size) but the substance might be dust explosible with a higher fines content this should also be communicated via the SDS. However, according to our experience safety data sheets very often contain no or incorrect information about the explosion behavior of dusts. The reason for that could be that the author has no better information or the information he has is for a more coarse product. Downstream users therefore should not rely on the information given in the SDS only. In praxis the best way to get information about the explosibility is a test with a representative dust sample. For the future of the respective information in SDS' should be improved, e.g. by giving more detailed guidance to those who are preparing SDS'.	Germany

Response	*Country*
Ideally there should be data available at no cost from some public source (perhaps the regulatory authorities should administer a data base). However from my experience, it is up to an employer (user of the dust) to carry out the risk assessment that will include testing of the dust if they cannot determine the properties from some where else (from database, from supplier etc.). The employer may be the producer of the dust or they may just process a dust from an outside supplier. For dusts that are not classed as hazardous (that is they do not have an MSDS), the employer is most often carrying the burden in regard to Health and Safety. That said, there are requirements under our legislation with regard to suppliers of articles, in that they are required to supply information on the article that is relevant to Health and Safety. It should be possible to ensure any manufacturer of hazardous substances carries out the necessary testing to determine any explosive properties of powders they supply and label them accordingly (noting that these substance are already labelled for some other criteria, toxic, dangerous to environment etc.). The testing of the non hazardous dusts (no MSDS) is usually carried out by the employer that uses the dust. This employer may not have a process that could give rise to a dust explosion and may be a very small employer that could find the cost of the testing prohibitive. In this instance it would be ideal if the employer could access a database that has the relevant information for his/her dust.	Ireland
Per *Directive 1999/92/EC 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres* *Article 7* **Places where explosive atmospheres may occur** 1. The employer shall classify places where explosive atmospheres may occur into zones in accordance with Annex I.	Netherlands
From SDS only.	South Africa
Published data is only a guide. The vertical tube test is normally used to classify a dust as either Group A Explosible or Group B Non-explosible. The 20 litre sphere apparatus can also be used for dust classification (see Kuhner operating manual).	UK
Because particle size plays a role in the rate at which a deflagration can propagate, use of published data may not be appropriate where the data is not representative of the particle size of a particular dust at a workplace. The Kst (deflagration index) value (whether published or developed through testing) is useful in designing vent sizing or suppression systems. Use of published data that is not representative of the particle size present at a particular facility may result in under-sizing vents to deflagrate any explosions or in installing explosion suppression systems that may not activate fast enough to suppress an explosion. OSHA therefore believes that published Kst data should never be used for sizing vents and designing explosion suppression systems.	USA

B. Testing

3. Is responsibility assigned (by law) for determining if a dust presents an explosion hazard? If so, must the person making the determination have any expertise or qualifications?

Response	*Country*
In Australia, the ultimate legally responsible party is anyone who has a legislated duty of care to ensure that the risks associated with the potential hazard of a dust explosion are managed to ensure that an explosion does not occur. These would include: • The owner of a facility where the dust is generated, stored, used or handled, and • The manufacturer or supplier of the dust who should advise in their MSDS of all potential hazards associated with its use. The practical risk of a dust explosion occurring will vary enormously according to the environment in which it is present. Therefore, considerable practical and theoretical expertise is required in order to determine the presence or extent of such a hazard and the likely outcomes should an explosion occur. In Australia private engineering consultants generally provide this risk assessment service to industry. They also often recommend or provide technical mitigation advice or particular products/technologies. This service is not normally provided through Government owned organizations. These consultants often advise their clients to have their samples tested to determine if their dust is explosive and/or to determine the dust explosion indices. There are two government owned testing laboratories in Australia who undertake explosibility tests on dust samples. There are TestSafe and Simtars. They have been providing these services for more than two decades. They have the testing equipment, experienced staff, training and quality accreditation in order to provide a reliable testing service.	Australia
~~Not answered~~ A supplier who intends to sell or import a product for use in a workplace in Canada must evaluate the product to decide if it is a hazardous product under the Workplace Hazardous Materials Information System (WHMIS) and therefore subject to WHMIS labelling and safety data sheet requirements. To classify a product, the supplier must consider all of the physical hazard and health hazard criteria listed in Part IV of the *Controlled Products Regulations* (CPR). The CPR do not currently include criteria for combustible dusts; however, as part of the initiative to implement the GHS for workplace chemicals in Canada, a new hazard class for Combustible Dusts is proposed to be added to the Regulations.	Canada
For the determination, several years of relative work experiences and the relative education background may be competent. In China, the customer can select a lab, which has been certificated by China National Accreditation Service for Conformity Assessment (CNAS), to test the dust explosion parameters. However, the person who supply consultation on the protection of dust explosion must have more expertise or qualification, for example, register safety engineer qualified by state.	China

Response	*Country*
The responsibility for determining if a dust presents an explosion hazard is settled in different directives. Directive which has to be complied by the employer: According to the German Ordinance on Industrial Safety an Health (http://osha.europa.eu/fop/germany/de/docs/legislation/betrsichv_englisch.pdf) a implementation of Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) the employer is responsible for hazard assessment of the workplace. According to Annex I of that Directive he has to classify hazardous places where explosive atmospheres in the form of a cloud of combustible dust can occur into Zone 20, 21 or 22 (depending on the duration and the frequency) and define the right precaution corresponding to the Zone 20, 21 or 22. Regulation which has to be complied by the manufacturer: The natural or legal person who manufactures, imports, or place a substance on the market is responsible for determining the properties of a substance and has to communicate this information via the SDS. According to REACH (new Annex II, as laid down in Regulation (EU) No 453/2010) "Other hazards" have to be communicated in the SDS. Dust explosion hazards are explicitly listed in this connection. Furthermore, REACH requires that the SDS is written by a competent person. (Obligation of REACH: http://www.reach-clp-helpdesk.de/nn_66152/en/Downloads/REACH-Verordnung-1907-2006-en.pdf?) However, see our remarks on the quality of SDS under 2.	Germany
Testing is usually carried out by a third party at considerable cost. I believe that there are no test houses in Ireland. Most samples are sent to laboratories in the UK.	Ireland
Per *Directive 1999/92/EC 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres* *Article 4* **Assessment of explosion risks** 1. In carrying out the obligations laid down in Articles 6(3) and 9(1) of Directive 89/391/EEC the employer shall assess the specific risks arising from explosive atmospheres, taking account at least of: • the likelihood that explosive atmospheres will occur and their persistence, • the likelihood that ignition sources, including electrostatic discharges, will be present and become active and effective, • the installations, substances used, processes, and their possible interactions, • the scale of the anticipated effects. Explosion risks shall be assessed overall.	Netherlands
Is responsibility assigned (by law) for determining if a dust presents an explosion hazard? Yes. If so, must the person making the determination have any expertise or qualifications? Yes - master electrician.	South Africa

Response	*Country*
It is the duty of employers to comply with the Dangerous Substances and Explosive Atmosphere Regulations 2002 (DSEAR) which seek to eliminate, reduce and control the fire and explosion risks from dangerous substances. Flammable powders capable of fueling a dust explosion fall within the definition of a dangerous substance. Regulation 5 of these regulations requires that, where a dangerous substance is present at a workplace, the employer should make a suitable and sufficient assessment of the risks to their employees. Those risks should, where possible, be eliminated. Where it is not reasonably practicable to do this they should be reduced and controlled (Regulation 6).	UK
OSHA requires the employer to understand hazards in the workplace, including dust explosion hazards. In addition, OSHA requires manufacturers and importers whose products could create combustible dust hazards under normal conditions of use or foreseeable emergencies to conduct a hazard ~~determination~~ evaluation and classification that warns downstream users of this potential hazard. OSHA believes it is important that an individual with expertise in the area of combustible dusts or explosion mitigation determine whether a dust presents an explosion hazard. At present, OSHA does not dictate testing requirements.	USA

4. Are there any prescribed tests to determine the explosibility of materials when in dust form? If so, please provide copies (in English, if possible)

Response	*Country*
The basic tests are conducted generally in accordance with ISO 6184. This standard however is very limited in its description of testing. Adolf Kuhner 20L apparatus test methods give more detailed instruction. The basic test to determine if a dust is explosible or not utilises a 2kJ ignition source.	Australia
~~The *Discussion Document – Draft – Revision 1, Implementing the GHS in WHMIS, Prepared by the Legislative, Regulatory and International Affairs section, National Office of WHMIS, March 2010* only talks about "acceptable test methods" but stops short of saying what that means.~~ ~~However, a working paper that WHMIS had prepared on this issue includes:~~ ~~""*Accpetable*" test methods are those which have been carried out in accordance with generally accepted standards of good scientific practice at the time the test was carried out. Examples of acceptable test methods for dust explosibility include the following: ASTM E1266-88 "Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dusts"; ISO 6184/1-1992 "Explosion Protection Systems – Part 1: Determination of Explosion Indices of Combusible Dusts in Air"; and ASTM 1515 "Standard Test Method for Minimum Explosible Concentration of Combustible Dusts"."~~ Canada's regulatory proposal to implement the GHS does not prescribe any particular tests to determine the explosibility or combustibility of substances or mixtures in dust form.	Canada
In China, there are not relative regulations which require tests on the explosibility of dust. The tests requirement are mainly from the company's self-desire on the protection of dust explosion. However, there are some state standards can be referred.	China

Response	*Country*
According to VDI 2263 part 1 tests in 20-l- or 1-m³- vessel are done. The test is also described in the manual of the manufacturer: http://www.kuhner.com/_upl/files/B000_071.pdf The tests can also be done in the modified Hartman tube but the result is not in all cases safe, so that sometimes additional tests in the closed vessels have to be done. However, at the moment exists no European directive for the determination of the explosibility. The reason for that might be that the test procedures for the determination of the parameter differ slightly from country to country.	Germany
The three most important tests are 1. Classification Test 2. Dust Explosion Severity/Pressure Time Characteristics (Standard EN14034) 3. Minimum Ignition Energy (Standard IEC 61241-2-3 or EN13821) Other tests 4. Layer Ignition Temperature (Standard IEC 61241-1 or EN50821-2-1) 5. Minimum Oxygen Concentration (Standard EN14034) 6. Minimum Ignition Temperature (Standard IEC 61241-2-1 or EN50821-2-1)	Ireland
Per the *Non-binding guide to good practice for implementing the European Parliament and Council Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres* **2.1. Methods** Suitable methods for assessing the explosion risks associated with work processes or plants are those which lend themselves to a systematic approach to checking plant and process safety. In this context,'systematic' means that the work is done in a structured manner, on an objective and logical basis. An analysis is made of the existing sources of hazardous explosive atmospheres and the effective sources of ignition which could occur at the same time. In practice, it is usually sufficient to determine and assess the explosion risk by working systematically through a set of focused questions.. **2.2. Assessment criteria** To check whether these conditions are met, explosion risks can, in practice, be assessed by means of seven questions. The first four questions are used to determine in principle whether there is an explosion risk and whether explosion protection measures are necessary at all. Only if this is the case should the other three questions be considered to determine whether the proposed protective measures limit the explosion risk to an acceptable level. This step must be performed in conjunction with the choice of protective measures and repeated if necessary until an overall solution appropriate to the circumstances is found.	Netherlands
Not answered	South Africa
The procedure for measuring the explosion severity of dust/air mixtures is described in a European standard available as BS EN 14034-1 (2004) and BS EN 14034-2 (2006). The peak maximum explosion pressure, P_{max}, and the peak maximum rate of pressure rise, $(dP/dt)_{max}$, are measured in this standard test procedure.	UK
Internally, OSHA relies on one of the two tests in determining whether a dust is combustible – Kst test (a test method for determining the normalized rate of pressure rise) and Class II test. Class II tests are conducted if the electrical equipment used in the area handling combustible dusts may have to be classified for the hazardous locations as described in OSHA's electrical standards. Class II tests are not generally conducted in the private sector. If electrical equipment used at a facility handling combustible dust is not in question, then OSHA will conduct the Kst test for other hazards found at the site.	USA

5. Indicate what additional tests are conducted to determine the level of explosibility of a particular dust. If there are tests, are they generic or specific to the circumstances of the particular dust?

Response	*Country*
Tests are conducted according to ISO 6184 or equivalent. This provides the following information: – What dust explosion class it falls into; – The maximum explosion overpressure (Pmax); – The normalized maximum rate of pressure rise (Kst). – The particle size and moisture content are also reported. In addition to this: – The Minimum Explosive Concentrations (MEC) are determined according to either the ISO 6184, the ASTM E 1515 – 93 or Kuhner 20L apparatus methods. – The Minimum Ignition Energy (MIE) is determined according to the Kuhner Mike 3 method and IEC Standard 1241.2.3 and the equivalent Australian Standard. – The Minimum Ignition Temperature as a dust cloud to IEC Standard 1241.2.1 and the equivalent Australian Standard.	Australia
Not answered	Canada
Test of particle size and moisture content are conducted. I think they are generic.	China
We have in Europe test methods for the maximum explosion overpressure, the maximum rate of pressure rise as well as the KSt-value which is calculated from the pressure rise, the lower explosion limit and the limiting oxygen concentration. These tests are described in the European Standards EN 14034 1-4 (Part 1: Determination of the maximum explosion pressure pmax of dust clouds / Part 2: Determination of the maximum rate of explosion pressure rise (dp/dt)max of dust clouds / Part 3: Determination of the lower explosion limit LEL of dust clouds / Part 4: Determination of the limiting oxygen concentration LOC of dust clouds). In Addition to that we have the Standard EN 13821 for the determination of the minimum ignition energy of a dust cloud, the standard EN 15188 for the determination of spontaneous ignition behavior of dust accumulations, EN 50281-2-1 “Electrical apparatus for us in the presence of combustible dust, part test methods and especially” and in Germany the VDI-guideline 2263 Part 1.	Germany
The Authority has investigated a dust explosion incident where it was revealed that the minimum ignition given by the supplier was incorrect (in excess of 200mj). The material was tested after the event by a laboratory in the UK. Its MIE was found to be less than 10mj. This difference was believed to be as a result of the testing regime. However, it is important to point out that any testing must be carried out on an appropriate representative sample of the dust. I believe the standards dictate the material being tested should be less than a certain particle size (circa 70 microns) and have low moisture content.	Ireland

Response	*Country*
We have in Europe test methods for the maximum explosion overpressure, the maximum rate of pressure rise as well as the KSt-value which is calculated from the pressure rise, the lower explosion limit and the limiting oxygen concentration. These tests are described in the European Standards EN 14034 1-4 (Part 1: Determination of the maximum explosion pressure pmax of dust clouds / Part 2: Determination of the maximum rate of explosion pressure rise (dp/dt)max of dust clouds / Part 3: Determination of the lower explosion limit LEL of dust clouds / Part 4: Determination of the limiting oxygen concentration LOC of dust clouds). In Addition to that we have the Standard EN 13821 for the determination of the minimum ignition energy of a dust cloud, the standard EN 15188 for the determination of spontaneous ignition behavior of dust accumulations, EN 50281-2-1 "Electrical apparatus for us in the presence of combustible dust, part test methods and especially" and in Germany the VDI-guideline 2263 Part 1.	Netherlands
Individual companies do not do tests on specific dusts and rely on information in SDS's.	South Africa
Tests are carried out to establish characteristics such as the minimum ignition energy (MIE) BS EN 13821:2002, Minimum ignition temperature (MIT) of a dust layer and dust cloud BS EN 14034-3.	UK
In the U.S., it is up to the employer to determine the applicable dust characteristics to design safe dust-handling processes. In that respect, the employer may use ASTM standards for testing, including: • ASTM E1226 (Standard Test Method for Explosibility of Dust Clouds) • ASTM E1515 (Standard Test Method for Minimum Explosible Concentration of Combustible Dusts • ASTM E2019 (Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air) Internally, there are several tests in determining the properties of combustible dusts. The following are a series of tests which may be performed at OSHA's Salt Lake City Technical Center to determine the explosibility and combustibility parameters of the dust. Percent through 40 mesh Percent moisture content Percent combustible material Percent combustible dust Metal dusts will include resistivity Minimum explosive concentration (MEC) Minimum ignition energy (MIE) Class II test Maximum normalized rate of pressure rise (dP/dt) – Kst Test Minimum ignition temperature (MIT) The details of these tests are found in Appendix E of the OSHA's Combustible Dust National Emphasis Program (NEP). The testing at OSHA's Testing Center is done using a Bureau of Mines (BoM) 20-liter low turbulence chamber. The results of the Kst values are compared with Pulverized Pittsburgh Coal. As a reference, Pulverized Pittsburgh Coal in a BoM 20 liter chamber has an average K_{st} of $\frac{25 bar \times meter}{\sec}$. The results obtained from this equipment cannot be used in designing of engineering protective safety equipment.	USA

6. Do you have any dusts that you assume to be explosible or that present an explosion hazard, and, thus, preclude the need or expense of testing? If so, please indicate what type of dust

Response	*Country*
We don't normally assume that a dust is or is not explosive. We usually test.	Australia
Not answered	Canada
Even for the most common dust, such as the food dust, the dust explosion may exist in the production, transportation and storage process. For example, dust cloud may form during the transfer of food dust in the port, at this condition, an explosion may occur when the dust cloud ignited by a high ignition energy. Therefore, we suggest that the company could determine the minimum explosion concentration (MEC) of dust cloud, and monitor the concentration of dust in the transfer process to ensure the concentration is under the MEC.	China
Most organic solids dust and many metals in the form of dust are explosible if they are fine enough. Characteristics of more than 4000 are listed in the GESTIS STAUB EX Database. The information in the GESTIS STAUB EX Database produced by IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance) may be used instead of determining the explosion hazard of a dust by testing (keeping in mind the limits of applicability as mentioned under 2.). The database includes important combustion and explosion characteristics of more than 4000 dust samples from virtually all sectors of industry were determined as a basis for the safe handling of combustible dusts and for the planning of preventive and protective measures against dust explosions in dust-generating and processing plants. There are limits of applicability of the combustion and explosion characteristics specified in these tables. They are based on the wide variation possibilities in the nature of the dusts (e.g. composition, particle size distribution, surface structure, moisture content), on the one hand, and on the dependence of the numerical value of the characteristics on the test methods, on the other. Hence, the user must always be aware that the tabulated values can only serve as a guideline for the design of preventive and protective measures. English Version http://www.dguv.de/ifa/en/gestis/expl/index.jsp	Germany
	Ireland
	Netherlands
Not answered	South Africa
Unless a dust is known to be inert, then it should be tested.	UK
No, OSHA has published guidance on materials that tend to be combustible (explosible), with the caveat that it is also dependent on dust characteristics. The guidance is available at the following address: http://www.osha.gov/Publications/3371combustible-dust.html. Employers may use the worst-case scenario at their workplace and design accordingly, or they may choose to test.	USA

C. Hazard communication

7. Do you require SDSs to communicate the hazards associated with dust explosions? Do you require SDSs to list mitigation measures? If so, please provide the reference for these requirements

Response	*Country*
At present the data is either never provided or is often unreliable. It would be most beneficial if such data was provided through Safety Data Sheets. Testing carried out for clients is considered confidential as they paid for the testing and therefore the data often never gets to be made public.	Australia
~~Not answered~~ Currently, there are no criteria for explosible or combustible dusts in the federal *Hazardous Products Act* or in the *Controlled Products Regulations* (CPR). However, a supplier is obliged to disclose on a material safety data sheet, in addition to the items of information specified in the Regulations, all additional hazard information that is available to the supplier with respect to the hazardous product or, if appropriate, a product, material or substance that has similar properties, including any evidence based on established scientific principles. This may include the potential for dust combustibility or explosibility, if this is applicable to the hazardous product. An example of this situation would be zinc dust, which is not only a flammable solid but is also capable of forming explosible mixtures with air. Preventive measures, including personal protective equipment, specific engineering controls, and safe handling procedures, are required to be disclosed on SDSs. As part of the initiative to implement the GHS for workplace chemicals in Canada, a new hazard class for Combustible Dusts is proposed to be added to the Regulations. In addition, the requirements for SDSs are proposed to be amended to align with the standardized 16-heading GHS format. The classification of a hazardous product would be required to be disclosed under the second heading (Hazard Identification). Thus, once the GHS is implemented in Canada, a product that meets the criteria for Combustible Dusts would be classified accordingly and this hazard classification would be disclosed on the product's SDS. Mitigation measures would be expected to be listed under headings 6 (Accidental release measures) and 8 (Exposure controls/Personal protection). References: (1) Government of Canada, *Controlled Products Regulations*; SOR/88-66 P.C. 1987-2721; December 31, 1987. (http://laws-lois.justice.gc.ca/PDF/SOR-88-66.pdf) (2) Regulatory proposal to repeal and replace the *Controlled Products Regulations* to implement the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in Canada, and to make consequential amendments to related regulations. (Notice published in the *Canada Gazette*, Part I, vol. 147, no. 26; June 29, 2013: http://www.gazette.gc.ca/rp-pr/p1/2013/2013-06-29/html/notice-avis-eng.html)	Canada
If there is enough information on which chemicals have the dust explosion hazards and mitigation measures for reference, SDSs may list them. But, at present, the dust explosion has not been included in the SDSs.	China

Response	*Country*
Dust explosive hazards are to be mentioned in section 2 of the SDS (required by the REACH Regulation Article 31 Requirements for safety data sheets and ANNEX II GUIDE TO THE COMPILATION OF SAFETY DATA SHEETS and No. 6.2 of Bekanntmachung 220, an announcement of the German Ministry of Labor) REACH Regulation http://www.reach-clp-helpdesk.de/cae/servlet/contentblob/700000/publicationFile/45309/REACH-Verordnung-1907-2006-en.pdf In addition the test results have to be published in the physico-chemical data section of the SDS (required by No. 6.9.4 of Bekanntmachung 220, an announcement of the German Ministry of Labor) General mitigation measures should be recommended especially in the handling and storage-section of the SDS. Based on this an employer has to determine during his hazard assessment, which measures he has to implement at his workplace. Maybe the extended SDS for substances under REACH (but not mixtures) will give more specific mitigation measures. It is important that the SDS lists the important characteristics of the dust, so that the user has information for the risk assessment and the selection of measures (see however our remark on the quality of SDS' under 2.) The actual application and realization of mitigation measures are in the responsibility of the employer (see above under 3.). It is his responsibility to decide whether an explosible dust actually poses a hazard. This depends on many more conditions which are not part of the SDS (and cannot be part of the SDS because they are not specific to the substance but to process and the handling conditions). Therefore the employer has to specify mitigation measures which are appropriate considering all relevant conditions such as the process in which the dust is used and the conditions under which it is handled.	Germany
SDSs could potentially be used to communicate dust explosion hazards for materials that have SDSs already. From experience the hazards associated with dusts are not well known in some sectors and can not communicated by an employer to employees unless the dust has been tested and is then known to present a risk.	Ireland
REACH Annex II, SDS **Section 2.3. Other hazards** states: *Information shall be provided on other hazards which do not result in classification but which may contribute to the overall hazards of the substance or mixture, such as formation of air contaminants during hardening or processing, dustiness, dust explosion hazards, cross-sensitisation, suffocation, freezing, high potency for odour or taste, or environmental effects like hazards to soil-dwelling organisms, or photochemical ozone creation potential.*	Netherlands
Not specifically mentioned in law but Section 8 & 10 of the Occupational Health and Safety Act requires information to be provided on the hazard of products supplied which would infer that the information would need to be provided.	South Africa
The HSE publishes guidance documents to inform and provide advice on a range of hazards. With regard to dust explosions, the HSE has published HSG103 Safe Handling of Combustible Dusts: Precautions against explosions. The HSE website also provides additional guidance on hazards, regulations etc.	UK

Response	*Country*
It is OSHA's position that both the 1994 and 2012 ~~current~~ Hazard Communication Standard apply~~ies~~ to combustible dusts and ~~M~~SDSs for products that potentially generate combustible dusts under normal conditions of use or in foreseeable emergencies should inform downstream users of this hazard. The 2012 Hazard Communication Standard requires that chemical manufacturers and importers identify the hazards resulting from combustible dust resulting when processed downstream in Section 2 (Hazard Identification) of the SDS. In addition, the OSHA requires that the appropriate sections of the 16-section SDS contain the necessary information, including the necessary measures to prevent injuries and illnesses, suggested actions necessary to protect employees, and mitigation measures, should an incident occur.	USA

8. How is information on the hazards of, and controls for, dust explosions communicated to workers?

Response	*Country*
Most companies provide some sort of hazardous awareness training to their staff. The coal mining industry, which is heavily regulated, which Simtars is a part of, ensures every worker undergoes formal generic induction training on a regular basis. This training covers all hazards associated with the potential for coal dust explosions. Other industries are not so heavily regulated and the onus is on individual companies to provide the level of training they see fit bearing in mind their duty of care.	Australia
~~Not answered~~ Our response to question # 7 outlines Canada's current and proposed future requirements with regard to the provision of information on SDSs in relation to the hazards posed by combustible dusts and appropriate controls/mitigation measures for these hazards. In addition to the supplier requirements set out in the federal *Hazardous Products Act* and the associated *Controlled Products Regulations*, employer requirements are set out in federal, provincial and territorial occupational safety and health legislation and regulations. Employers are required to: (i) ensure that hazardous products used in the workplace are properly labelled; (ii) ensure that SDSs are made available to workers; and (iii) provide education and training to workers to ensure the safe storage, handling and use of hazardous products in the workplace.	Canada
File of "Standard operation process", education, and caution label and so on.	China
Zones as named above under 3. where explosive atmospheres in the form of a cloud of combustible dust can occur should be marked (see Art. 7 of Directive 1999/92/EC and the non-binding guide of good practice for implementing Directive 1999/92/EC is a good way). Among other directives and guidelines most detailed information how to communicate hazards of dust explosions to workers is mentioned in the Technical Rules for Hazardous Substances (TRGS 555) 'Working instruction and information for workers'.(http://www.baua.de/cln_104/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/TRGS-555.html)	Germany

Response	*Country*
Once a dust is identified combustible (by testing), it therefore is governed by the ATEX regulations in the EU(see below). These regulations and associated guidance (see below) require that the findings of the risk assessment be communicated to employees. The first part of the risk assessment (after testing of the material) being the Hazardous Area Classification. Training on organisational measures then come after the risk assessment, as does any technical measures that are required. Employers tend to use consultants to develop their control measures and communicate them to employees. The Authority uses press releases and/or safety alerts usually after an event to highlight to particular Industry Sector any pertinent safety information gleaned from an event. I am not aware of the Authority issuing any information in relation to dust explosions. From my discussions with colleagues (noting that the Authority has not compiled any data on dust explosions) it would appear that there have been very few reported dust explosions in the last 10 years. I could find no instances of secondary dust explosion. Two of the events that I have researched involved high energy milling where equipment failures lead to the ignition.	Ireland
Per *Directive 1999/92/EC 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres* 1.1. *Training of workers* The employer must provide those working in places where explosive atmospheres may occur with sufficient and appropriate training with regard to explosion protection. 1.2. *Written instructions and permits to work* Where required by the explosion protection document: — work in hazardous places must be carried out in accordance with written instructions issued by the employer, — a system of permits to work must be applied for carrying out both hazardous activities and activities which may interact with other work to cause hazards. Permits to work must be issued by a person with responsibility for this function prior to the commencement of work. Where necessary, places where explosive atmospheres may occur in such quantities as to endanger the health and safety of workers shall be marked with signs at their points of entry in accordance with Annex III. *ANNEX III* Warning sign for places where explosive atmospheres may occur, pursuant to Article 7(3):  	Netherlands
Via training and included in standard operating procedures and then trained. (Depend on the company but if they are wanting to comply).	South Africa

Response	*Country*
As above	UK
~~It~~ The employer is required to inform employees of the hazards to which they are exposed under the training provisions of OSHA's Hazard Communication Standard. This includes explaining the hazard, labelling elements (hazard statement, signal word) and the information expected on the SDS.	USA

9. If appropriate, what information is placed on labels to identify the possibility of a dust explosion hazard?

Response	*Country*
We are unaware of any standardized labeling relating to dust explosion hazards.	Australia
Proposed ~~Classification Criteria and~~ Labelling Elements for ~~Explosible~~ Combustible Dusts in the Canadian Workplace Hazardous Materials Information System (WHMIS) Hazard Classification: Category 1 – ~~Explosible~~ Combustible Dusts Symbol: ~~Exploding bomb~~ No symbol Signal Word: ~~Danger~~ Warning Hazard Statement: ~~May form explosible dusts~~. May form combustible dust concentrations in air	Canada
"possible dust explosion"	China
Something like that for the labeling for dust explosion does not exist. Otherwise it is difficult to label products with information about dust explosion hazards, because the explosion hazard does not depend on the dust alone, it mainly depends on the way it is handled. The likelihood of occurrence of explosible dust atmospheres is more influenced by the surrounding conditions than by the intrinsic characteristics of a dust.	Germany
As already stated dust explosion hazards are not communicated by labelling.	Ireland
	Netherlands
None	South Africa
Not answered	UK
~~OSHA's Hazard Communication Standard is performance oriented and label information for this hazard is not specified. However,~~ OSHA'S Hazard Communication Standard, updated in 2012 to align with the GHS, requires that labels for shipped containers presenting a dust hazard to include the following: • Identify the hazard, "Combustible Dust", • Include the signal word "Warning", and • Include the hazard statement, "May form combustible dust concentrations in air." • No pictogram is required. OSHA allows partial labelling exemptions based on the use of the chemical. In addition, the Hazard Communication Standard requires that containers in the workplace be labelled such that employees are informed of the hazard in the area where they work. In addition, accident prevention signs are required for hazards, such as dust explosion hazards.	USA

Response	*Country*
The requirements for these signs are found at 28 CFR 1910.145, Specifications for accident prevention signs and tags.	

D. Standards

10. What standards or guides are used in your country to address explosible dusts in any manner (definition, testing, hazard recognition, hazard assessment, hazard communication, mitigation methods, emergency response, investigation, etc.)? Indicate if they are used throughout your country, or in a portion (state, province, city, etc.). Please provide a copy (in English, if possible)

Response	*Country*
The application of a national code of practice in any jurisdiction, including the Commonwealth, is the prerogative of the Commonwealth, or a State or Territory. However, even if not mandated by legislation, these standards and codes can still be afforded evidentiary status, as proof that a person was not abiding by their 'duty of care' responsibilities, by applying current best practice systems, in light of current industry knowledge and practice. The following AS/NZS Standards are used throughout Australia. The AS/NZS 61241 series are local equivalents to the EN 61241 series. a. AS/NZS 4745:2004. "Code of practice for handling combustible dusts. *(copy to be attached)*. b. AS/NZS 61241.10:2005 / Amdt1:2007 "Electrical apparatus for use in the presence of combustible dust – Classification of areas where combustible dusts may be present". c. AS/NZS 61241.2.1:2000 Electrical apparatus for use in the presence of combustible dust. Test Methods – Methods for determining the minimum ignition temperature of dust. d. AS/NZS 61241.2.3:2000 Electrical apparatus for use in the presence of combustible dust. Test Methods – Methods for determining the minimum ignition energy of dust/air mixtures. e. ISO 6184 /1 Determination of Explosion Indices of combustible dusts in air. f. AS/NZS 61241.0:2005 Electrical apparatus for use in the presence of combustible dust. General requirements g. AS/NZS 61241.1:2005 Electrical apparatus for use in the presence of combustible dust. Protection by enclosures "tD". h. AS/NZS 61241.11:2006 Electrical apparatus for use in the presence of combustible dust. Protection by Intrinsic Safety "iD". i. AS/NZS 61241.14:2005 Electrical apparatus for use in the presence of combustible dust. Selection and Installation. j. AS/NZS 61241.18:2005 Electrical apparatus for use in the presence of combustible dust. Protection by encapsulation. k. Queensland Coal Mining Safety and Health Regulation 2001. l. NSW Coal Mine Health and Safety Regulation 2006. These joint Australian and New Zealand standards are published by a private organization, the parent company being Standards Australia [http://www.standards.org.au], with the standards development arm established as SAI Global [http://www.saiglobal.com]. The standards and codes are sold to partially offset the costs to the organization. Standards Australia develops and produces the codes by way of consultative groups set up and managed by the organization. Those consultation groups generally consist of technical expert	Australia

Response	*Country*
representatives, drawn mainly from industry and government. Most of the Australia/New Zealand standards are developed with consideration for; International Standards Organisation (ISO) and European Norm (EN) Standards, with most replicating ISO requirements for international consistency.	
~~The above proposed Classification Criteria and Labelling Elements for Explosible Dust in the Canadian Workplace Hazardous Materials Information System (WHMIS) are in the *Discussion Document – Draft – Revision 1, Implementing the GHS in WHMIS, Prepared by the Legislative, Regulatory and International Affairs section, National Office of WHMIS, March 2010*~~. The proposed definition, classification criteria and labelling elements for Combustible Dusts, as described above, are in the Regulatory Proposal to repeal and replace the *Controlled Products Regulations* to implement the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in Canada, and to make consequential amendments to related regulations. (Notice published in the *Canada Gazette*, Part I, vol. 147, no. 26; June 29, 2013: http://www.gazette.gc.ca/rp-pr/p1/2013/2013-06-29/html/notice-avis-eng.html).	Canada
In China, there are some standards about the determination of dust explosion. However, all of these standards are in Chinese form. These standards include: GB/T 16425-1996 Determination for minimum explosive concentration of dust cloud GB/T 16426-1996 Determination for maximum explosion pressure and maximum rate of pressure rise of dust cloud GB/T 16427-1996 Determination for electrical resistivity of dust in layer GB/T 16428-1996 Determination of the minimum ignition energy of dust cloud GB/T 16429-1996 Determination of the minimum temperature of dust cloud GB/T 16430-1996 Determination of the minimum ignition temperature of dust layer GB 3836 Electrical apparatus for explosive gas atmospheres GB 12476 Electrical apparatus for use in the presence of combustible dust GB 4385 Technical requirements for antistatic footwear and conductive footwear GB 15577 Safety regulations for dust explosion prevention and protection	China
The basis for all the European standard and German laws, orders and regulations dealing with explosions prevention and protection are the European Atex-directives. Directive 94/9/EC deals with the placing on the market of equipment and protective systems intended for use in potentially explosive atmospheres. Because it affects the free trade between the member states of the European Union it has to be implemented into german laws without any changes in the content (made by 11. GSGV). This directive is underlayed with mandated standards from CEN (European Committee for Standardization). Directive 1999/92 includes minimum requirements on workplace safety. Every state in Europe was allowed to demand a higher safety level. The german implementation is the Ordinance on Industrial Safety and Health and the Hazardous Substances Ordinance (http://osha.europa.eu/fop/germany/de/docs/legislation/betrsichv_englisch.pdf) (http://www.baua.de/nn_39406/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/pdf/Hazardous-Substances-Ordinance.pdf?) for the employer. The Ordinances are substantiated in the technical rules on industrial safety and health and the technical rules for hazardous substances. In this technical rules are e. g. mentioned hazard analysis, explosion prevention and protection, testing of equipment in hazardous areas and hazards do to electrostatic discharges. For now these technical rules exist mainly in German Some are already translated but only general rules for risk assessment and substitution.	Germany

Response	*Country*
(http://www.baua.de/cln_137/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/TRGS.html) The basic standard for explosion prevention and protection in Europe is EN 1127-1. In addition to that exists a definition standard and several standard for electrical and non electrical equipment, test methods for explosible substances (gases, liquids, dusts) and for explosions protection systems They exist as a minimum in English, German and French and probably in Spanish language. Unfortunately European standards are not allowed to copy also for internal use. An overview of the most standards you will find on: http://www.cen.eu/CENORM/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/CENTechnicalCommittees.asp?param=6286&title=CEN%2FTC+305 and http://www.cenelec.eu/Cenelec/Technical+work/TC+web+sites/TC31/default.htm In addition to that we have guidelines and rules of the German Social Accident insurances and VDI-guidelines to special topics and processes. Guideline VDI 2263 and its parts 1-9 Dust fires and Dust Explosions Hazards – Assessment – Protective Measures The Guideline serves to assess the hazards and the measures taken to prevent dust fires and dust explosions, as well as their dangerous results. It is not effective for substances and mixtures which are subject to the law on explosible substances. Among the listed standards and guidelines there exists a lot of other national and European which describes measures how to avoid ignition sources and to mitigate the effects of dust explosions.	
The Authority has not developed any regulations, codes of practice or standards that explicitly deal with dust explosions. The Authority (like other EU Member States) has transposed two EU Directives with regard to flammable atmospheres. The first set of regulations often referred to as the Products Directive (94/9/EC) applies to manufacturers/suppliers of equipment and protective systems for use in explosive atmospheres (CE Marking). These came into effect in 1999. Whilst the Authority has no guidance on this we would often refer people to the EU Guidance on same. The second set of regulations often referred to as the Users Directive (1999/92/EC) applies to employers who have workplaces where flammable atmospheres are present. These came into effect in June 2003. The Authority has issued some general guidance on these that I attach. The Authority has also issued some FAQs sheet that I also attach. This directive introduced the formal requirement for hazardous area classification. Both these directives are commonly referred to as the ATEX Directives I am sure the members of the group are already aware of ATEX. The Chemical Agents Directive (98/24/EC) was also transposed into law in 2001 by the Authority and covers general risk assessment requirements for chemicals and would fall more under the remit of occupational hygiene. The Authority has no explicit guidance with regard to dust explosion. However, we would refer to European Standards on occasions (EN1127 Part 1 Explosion Prevention and Protection Basic Concepts and Methology, EN 50281 Part 3). The Authority would also refer people to the EU Guidance on Directive 1999/92/EC.	Ireland

Response	*Country*
Directive 1999/92/EC 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres Non-binding guide to good practice for implementing the European Parliament and Council Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres	Netherlands
SANS 612421-10:2005/EC 61241:10:2004 Electrical apparatus for us in the presence of a combustible dust.	South Africa
The standards described in the replies above are applicable. Additionally, the following standards are used but there are likely to be many other relevant standards not listed: EN 1127-1: 2009, Safety of Machinery, Fire and Explosions, Part 1: Explosion Prevention and Protection EN 1050: 1996, Safety of machinery - Risk assessment EN 13463-1:2009 Non-electrical equipment for potentially explosive atmospheres – Part 1: Basic method and requirements EN 13463-6: 2005 Non-electrical equipment for use in potentially explosive atmospheres – Part 6: Protection by control of ignition source "b" EN 14491: 2006, Dust Explosion Venting Protective Systems EN 14460: 2006, Explosion Resistant Equipment EN 14797:2006, Explosion venting devices prEN 15089:2007, Explosion Isolation Systems EN 13821:2002 Potentially explosive atmospheres. Explosion prevention and protection. Determination of minimum ignition energy of dust/air mixtures EN 50281-2-1:1998 Electrical apparatus for use in the presence of combustible dust. Test methods. Methods of determining minimum ignition temperatures Electrostatics Code of Practice CLC/TR 50404-2003 Tech Report EN 618:2002 Continuous handling equipment and systems - Safety and EMC requirements for equipment for mechanical handling of bulk materials except fixed belt conveyors. References: Barton (2002), Dust explosion prevention and protection, ISBN 0 85295 410 7, Institution of Chemical Engineers EN 14034-1: 2004, Determination of explosion characteristics of dust clouds – Part 1: Determination of the maximum explosion pressure p_{max} of dust clouds. EN 14034-2: 2006, Determination of explosion characteristics of dust clouds – Part 2: Determination of the maximum rate of explosion pressure rise $(dp/dt)_{max}$ of dust clouds. BS EN 13237:2003, Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres. BS EN 13821:2002 Potentially explosive atmospheres — Explosion prevention and protection — Determination of minimum ignition energy of dust/air mixtures BS EN 14034-3 Determination of explosion characteristics of dust clouds – Part 3: Determination of the lower explosion limit LEL of dust clouds HSG103 Safe Handling of Combustible Dusts: Precautions against explosions. ISBN 07176 2726 8	UK

<table>
<tr><th>Response</th><th>Country</th></tr>
<tr><td>
The 2012 Hazard Communication Standard (29 CFR 1910.1200) requires the classification and communication of combustible dust hazards. This standard explains that employees exposed to a hazardous chemical in the workplace must be informed of the hazard and appropriate measures to protect themselves from the hazard. Communication of the hazard is provided by means of labels, SDSs, and training on the workplace hazards.
Other OSHA standards that address combustible dust concerns include:
• Grain Handling Standard, 29 CFR 1910.272, cover grain handling facilities (e.g., flour mills).
• Ventilation Standard, 29 CFR 1910.94, covers abrasive blasting; and grinding, polishing, and buffing operations.
• Housekeeping, 29 CFR 1910.22, when not a grain handling facility, and the surface dust accumulations (i.e., dust accumulations outside the dust collection system or other containers, such as mixers) can create an explosion, deflagration or other fire hazard.
• Housekeeping in storage areas, 29 CFR 1910.176.
• Housekeeping at coal-handling operations covered under 29 CFR 1910.269, for sources of ignition not eliminated or controlled where coal-handling operations may produce a combustible atmosphere from fuel sources)
• Personal Protective Equipment (PPE), 29 CFR 1910.132(a)
• Electrical Violations, 29 CFR 1910.307, for Class II dusts.
In the absence of an OSHA standard specific to combustible dust, OSHA can enforce section 5(a)(1) of the OSHAct,~~,~~ if workers during an inspection are found to be exposed to serious hazards, such as fire and explosion hazards, and there are feasible means of abatement. The industry consensus standards such as the National Fire Protection Association (NFPA) standards may be used in determining the potential means of abatement and establishing industry knowledge of the hazard. OSHA has used the following (but not limited to) NFPA standards in determining the feasible means of abatements and in establishing industry knowledge of the explosion hazards associated with combustible dust:
<table>
<tr><td>61</td><td>Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities</td><td>2008</td></tr>
<tr><td>68</td><td>Standard on Explosion Protection by Deflagration Venting</td><td>2007</td></tr>
<tr><td>69</td><td>Standard on Explosion Prevention Systems</td><td>2008</td></tr>
<tr><td>77</td><td>Recommended Practice on Static Electricity</td><td>2007</td></tr>
<tr><td>484</td><td>Standard for Combustible Metals</td><td>2006</td></tr>
<tr><td>499</td><td>Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas</td><td>2008</td></tr>
<tr><td>654</td><td>Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids</td><td>2006</td></tr>
<tr><td>664</td><td>Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities</td><td>2007</td></tr>
</table>
These standards are found on www.NFPA.org. In addition, OSHA may look to Factory Mutual
</td><td>USA</td></tr>
</table>

Response	*Country*
Combustible Dust related Data Sheets in determining the feasible means for combustible dust hazards. OSHA has developed several guidance documents, including Hazard Communication Guidance for Combustible Dust, a Combustible Dust Poster, Combustible Dust Fact Sheet, and a Combustible Dust Safety and Health Information Bulletin. All of these items are available on the OSHA web page at http://www.osha.gov/dsg/combustibledust/index.html.	

Annex III

Survey responses submitted on the dust explosion hazard survey by industry or industry association

A. Definition

1. How should explosible dust be defined - by minimum particle size, without regard for particle size, or should the definition vary for the type of dust?

Response	*Industry*
(a) It is most important that the dust be characterized by its physical parameters which would include an ability to remain in a cloud and when ignited to produce an overpressure (i.e. be explosible). Particle size is most definitely an important factor in this consideration and it may that dust in specific parts of the process which may require more attention, than just an average dust particle size. (b) The definition of a combustible dust must be one that may be understood by an average person to provide initial guidance on whether or not a dust 'explosible' hazard potential exists. Experience has showed us that because of the variants of dust, a definition for combustible dust cannot be all inclusive or without any aspects of fuzzy logic. Consider the following better examples for combustible dust definitions: From the work of NFPA 499: Combustible Dust. Finely divided solid particles that present a dust flash-fire or dust explosion hazard when dispersed and ignited in air. The term 'solid particles' addresses particles in the solid phase and not those in a gaseous or liquid phase and can include hollow particles. Dust which can accumulate on equipment and includes particles of 420 microns or smaller (material passing a U.S. No. 40 Standard Sieve) is considered to present a dust flash-fire or dust explosion hazard unless testing shows otherwise. (See ASTM E1226 or ISO 6184/1.) From the US National Electrical Code: Combustible Dust. Any finely divided solid material that is 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air. From the Dow Chemical Company: Combustible Dust – Any finely divided solid material, less than 420 microns in diameter (material passing a US No. 40 Standard Sieve), that presents a fire or deflagration hazard. If a sample of the dust that is at least 95% by weight less than 74 microns in diameter (US 200 mesh) explodes when tested in accordance with ASTM E 1226 "Standard Test Method for Pressure and Rate of Pressure Rise for Combustible Dust" it is termed "explosible" and should be considered a dust explosion hazard. (c) The importance of particle size is also quite evident from procedural statements in many of the recognized dust testing standards. For example, from ASTM E 1226 Paragraph 9.2-9.3 "Tests may be run on as-received sample. However due to the possible accumulation of fines at some location in a processing system, it is recommended that the test sample be at least 95% minus 200 mesh (75um). To achieve this particle fineness, the sample may be ground or pulverized or it may be sieved."	The Dow Chemical Company
Any definition of combustible dust must eventually be industry-wide globally, as simple as possible and define criteria for explosibility. This definition should be technically/scientifically based rather than based in regulatory-type framework.	American Chemistry Council (ACC)

Response	*Industry*
European reply: • We do not locally have any exact definition of explosible dusts but we can use this definition from the Norwegian Labour Inspection Authority: "Explosive (dust) atmosphere means a mixture of air and combustible components /dust where the combustion spreads out to the whole mixture after ignition." • The definition should vary by the type of dust. It should reflect the ease of ignition (MIE) and the severity of explosion (Pmax). • Not aware of any particle size limits in existing standards or legislation. It should be any solid that can form an explosive mixture with air (and for secondary explosions, this could be a relatively high particle size). USA reply: • No single, universally accepted definition of combustible dust is available. Even among standards promulgated by the same standards-developing organization, the definitions vary significantly. NFPA 654 and 655 define combustible dust in general terms without regard for particle size. This approach recognizes that factors such as particle shape, agglomeration, and other characteristics, can affect explosibility. Other standards (such as NFPA 61, 484, and 664) define combustible dust in terms of a minimum particle size. The definition in previous editions of NFPA 654 (which may still be used in some areas of the USA) was also size-based. Furthermore, OSHA's grain standard uses a size-based definition for "fugitive grain dust." In general, particle size is problematic, because real materials often contain a range of particle sizes, and so even though the median size is large, the finest material could still pose a hazard if it is allowed to accumulate. Our industry prefers the approach of defining combustibility based on a standardized (though not yet established) test method. Note that results are only applicable to material with similar particle size distribution to the material tested. A predetermined testing protocol should also be dictated (Standardized Methodology).	IPPIC
We would (generally) separate the definition of dust cloud explosibility from particle size. There do seem to be some dusts which are of sufficient size to be effectively non-flammable, but there seem to be very few cases where there is not a degree of attrition and hence a fraction of finer material which may then be flammable. This finer material is often found in filters and dust extraction systems. A safe position would be "can form explosible dust clouds in air". A detailed hazard and risk assessment might separate out times and places in a process plant where a dust will or will not be explosible, but that would be by expert assessment and not a default position, otherwise detail of filters and extract equipment can be overlooked. We do find that many end users find the terms explosive (as in dense phase explosive) and explosible confusing and use them interchangeably. We try to make a distinction by using phrases such "when dispersed as a dust cloud in air".	Syngenta

2. Do you determine whether a dust is considered explosible by reference to published data, testing, safety data sheets (SDSs), or some other means? Please explain

Response	*Industry*
(a) As stated above it is imperative that the physical properties and inherent potential risks of using chemical materials, including dusts, are known. Where adequate appropriate data can be found within published data it is used. However in many cases we may have to use both internal and external testing to determine the needed chemical characteristics and potential hazards. (b) Some of the test methods used include the ASTM E1226, Pressure Rate of Pressure Rise for Combustible Dusts, ASTM E2021, Hot Surface Ignition Temperature of Dust Layers, ASTM E2010 Minimum Ignition Energy for a Dust Cloud in air,	The Dow Chemical Company
ACC supports the use of SDSs for this purpose. However, if a supplier does not provide needed information, testing should be performed or published data and technical papers should be used to obtain needed data.	ACC
European reply: • Raw material is judged for explosibility by referring to information in their SDS's. Several of our own powder coating products have been tested and their potential dust hazard has been evaluated. • We rely on historical data and references in published data. Historically we assume all our powder coating dusts are explosible and we routinely quote in our SDS the MIE [5-20 mJ] and the Minimum explosible concentration as a range [20-70 g/m³] and the Explosion severity ST 1 for standard powder coatings. • For risk assessment in-use purposes, reference is to safety data sheets and published data, both of which are very scarce. Testing is expensive, especially if applied to every dust that we handle, and we have put much effort into trying to get more from raw material suppliers. In general, we extrapolate from existing data based on the chemistry of the material for which we have no data. USA reply: • All of the above. There is a great deal of data on combustible dusts in our industry. Many members treat ALL dusts as combustible to eliminate confusion.	IPPIC
Although there are exceptions safety data sheets often do not contain reliable or sufficient data for flammability properties of materials, and this is especially true for powders and dusts where little or no information is communicated. We make some reference to published data as to whether a dust is explosible, but generally rely on our own testing. As a company our recommended sources of data are from our own test reports or in assessments or summaries compiled by experts.	Syngenta

B. Testing

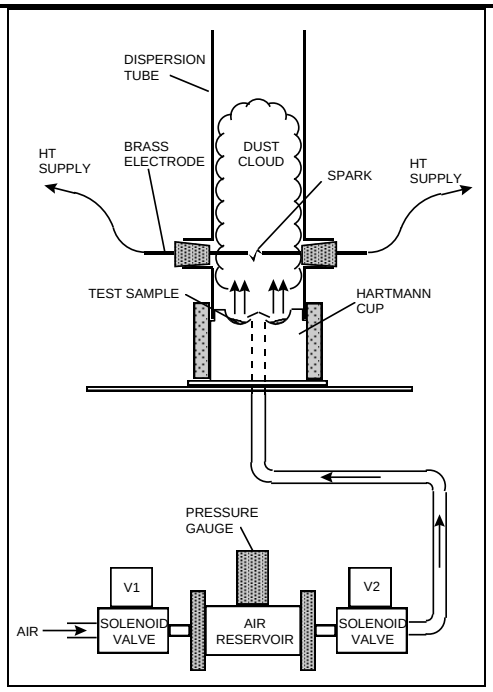
3. Is responsibility assigned (by law) for determining if a dust presents an explosion hazard? If so, must the person making the determination have any expertise or qualifications?

Response	*Industry*
Action is taken based upon the knowledge assessed during the design of the process so that a complete understanding of the fundamental hazards of the material(s) is known. This information is supplemented with our history of processing operations to enable to make an appropriate assessment as to the need for more information, which may come from performing testing.	The Dow Chemical Company
Local authorities dictate testing requirements via building codes and standards. Testing must reflect the condition of the material at the point of concern, which depends on the nature of the process. Therefore testing cannot be the sole responsibility of the supplier. The person making the determination must have a fundamental understanding of explosible dusts.	ACC
European reply: • This assignment of responsibility falls under general laws of workplace safety. The local leader shall provide for responsible and competent personnel. No specified qualifications are required. A local Norwegian regulation exists on "Health and safety in potentially explosive atmospheres". • There are responsibilities, expertise and qualification defined in several European and country specific regulations. • Users of relevant materials have to assess the risk (ATEX) and control it. Manufacturers' / suppliers' responsibilities seem to be a bit of a grey area probably because there is currently no requirement to classify (DSD/DPD in EU) for dust explosion hazards. USA reply: • Our industry employs both corporate and facility Health and Safety professionals that are trained in the recognition, evaluation, and control of health and safety hazards to include combustible dusts. These professionals also attend NPCA Occupational Health and Safety Committee meetings where these issues are discussed. The committee often publishes guidance documents for member use. As an example, the committee is currently completing a revision of a document title "Generation and Control of Static Electricity in Coatings Operations". The next "Guide" the committee has scheduled to develop is a "Powder Guide" to address this specific issue, among others in our industry. Often, for the development of a new product or facility, a team of professionals is assembled to include the H&S, Corporate Engineers, and often insurance and supplier representatives.	IPPIC
The operating plants are responsible for ensuring that risk assessments are carried out on their process and materials that they handle. There are trained risk assessors on our sites with regional experts in risk assessment overseeing them. They have at least an overview of fire and explosion hazards including dusts. These risk assessors carry out what we call "Process Risk Assessment" which conforms to the HazOp methodology. This methodology has triggers to look for data on material hazards. There are forms to record this data which indicates what data is needed as a "base data set" on which to base risk assessment decisions. This system is backed up by a global group of experts, codes of practice and other documentation, and a test laboratory. The experts are available to give guidance on appropriate test measurements, and detailed guidance on safe handling and appropriate precautions.	Syngenta

4. Are there any prescribed tests to determine the explosibility of materials when in dust form? If so, please provide copies (in English, if possible)

<table>
<tr><th>Response</th><th>Industry</th></tr>
<tr><td>a. Please see the ‘b’ response above.</td><td>The Dow Chemical Company</td></tr>
<tr><td>ASTM E1226 is the fundamental testing protocol used to determine dust explosibility in the US. Testing must reflect the process conditions under which the material will be subjected, and therefore additional testing may be needed depending on those conditions.</td><td>ACC</td></tr>
<tr><td>European reply:
• No prescribed tests are necessary to determine the explosivity of products and raw materials. But in our business we assume that most of the products and raw materials imply explosion hazards if they are combustible.
• Testing is defined by various ISO standards to determine the key explosivity figures like EN 13821, IEC 61241-2-3 for MIE or EN 14034 for pmax/ Kst.
• Yes, as follows:
<table>
<tr><th>Parameter / Property</th><th>Abbreviation</th><th>Reason</th><th>Test method(s)</th></tr>
<tr><td>Combustibility class</td><td>A (combustible) or B (non-combustible)</td><td>Determination of dust explosion risk NB - If B, only volume resistivity is also needed</td><td>Open vertical tube with ignition source (hot wire or continuous discharge) – ignition of dust and propagation of flame. www.kuhner.com/DOCUMENT/b031_021.pdf</td></tr>
<tr><td>Volume resistivity</td><td>(ohm/m)</td><td>Determination of static generation risk (ignition source for flammable vapours)</td><td>ASTM D257
IEC 60093</td></tr>
<tr><td>Maximum Explosion Pressure</td><td>P_{max}</td><td>Design of explosion protection equipment</td><td>ISO 6184-1:1985
ASTM E1226</td></tr>
<tr><td>Max. Rate of Pressure Rise</td><td>$(dp/dt)_{max}$</td><td>Design of explosion protection equipment</td><td>ISO 6184-1:1985
ASTM E1226</td></tr>
<tr><td>Calculation from $(dp/dt)_{max}$ and normalised to 1 m^3</td><td>Kst</td><td>Design of explosion protection equipment</td><td>ISO 6184-1:1985
ASTM E1226</td></tr>
<tr><td>Dust explosion classes from the Kst</td><td>St class 1,2 or 3</td><td>Design of explosion protection equipment</td><td>ISO 6184-1:1985
ASTM E1226</td></tr>
<tr><td>Minimum Explosive Concentration</td><td>MEC</td><td>Determination of dust explosion risk</td><td>ISO 6184-1:1985
ASTM E1515-03a
IEC 1241-2-1</td></tr>
<tr><td>Minimum (spark) Ignition Energy</td><td>MIE</td><td>Determination of dust explosion risk</td><td>ASTM 2019-03
IEC 1241-2-3
BS 5958-2</td></tr>
</table>
</td><td>IPPIC</td></tr>
</table>

<table>
<tr><th>Response</th><th>Industry</th></tr>
<tr><td>
<table>
<tr><td></td><td></td><td></td><td>BS EN 13821</td></tr>
<tr><td>Layer Ignition Temperature</td><td>LIT</td><td>Determination of dust explosion risk</td><td>ASTM 2021
IEC 1241-2-1</td></tr>
</table>
USA reply:
• There is a great deal of data on combustible dusts in our industry. Many members treat ALL dusts as combustible to eliminate confusion. In general, any organic material that is or becomes a dust or powder is considered a combustible dust.
</td><td></td></tr>
<tr><td>
The basic test for dust flammability is a vertical tube test – this is based on a method by P. Field, "Explosibility Assessment of Industrial Powders and Dusts" (HMSO London, 1983).
Some information on vertical tube test is summarized below. See also Figure 1
Explosible Dust - Group A: One which causes flames to move away from the ignition source
Non-Explosible Dust - Group B: One which does not propagate flame away from the ignition source.
Ignition: Any signs of flame seen around the ignition source or a flame propagating partially or fully up the tube. Smouldering propagating through the dust cloud is classified as an ignition provided it is not just a movement of smouldering particles caused by the dispersing air.
Non-Ignition: No signs of flame or smouldering of the dust cloud. The spark may be coloured by the test substance but this is regarded as non-ignition.
Any positive test will establish a material as Group A, but to establish group B requires much more testing.
(i) Screening Test - Material tested "as received" using standard experimental parameters
(ii) Extended Testing - Material tested "as received", and the experimental parameters are varied
(iii)Group B Test - Material tested after drying and sieving.
Standard parameters include a 10kV spark. Extended testing varies the dispersion, and Group B test can include a test with a hot coil if there is no positive result from a spark.
Testing normally proceeds to determining dust cloud Minimum Ignition Temperature (MIT) in a Godbert-Greenwald Furnace, and then Minimum Ignition Energy (MIE) in the MIKE3 apparatus.
MIT gives us :
Ignition < 1000°C: Flammable at Elevated Temperatures (with an ignition range)
Or No ignition ≤ 1000°C: Non-Flammable at Elevated or Ambient Temperatures.
</td><td>Syngenta</td></tr>
</table>

Response	*Industry*
 Figure 1: Vertical Tube Apparatus	

5. Indicate what additional tests are conducted to determine the level of explosibility of a particular dust. If there are tests, are they generic or specific to the circumstances of the particular dust?

Response	*Industry*
a. Additional testing may be done depending on the product and what happens when that product may come into contact with known other materials. Are there environmental considerations perhaps associated with aging, moisture concentrations, or solar heating?	The Dow Chemical Company
Additional testing may be performed depending on the product and what could happen when that product may come into contact with other known materials. For example, there may be environmental considerations associated with aging, moisture concentrations, or solar heating.	ACC
European reply: • In connection with risk assessment, we use the measures ignition energy and lower explosion limit, and also particle size distribution and humidity of the powders. Tests: - CEN/TC 305/WI 00305031 "Determination of minimum energy of dust/air mixtures" European draft standard 1998-10-20. - EN 50281-2-1 1998: Part 2-1: Methods for determining the minimum ignition temperatures of dust" European Standard 1998 - EN-14034-3 2004 : "Determination of explosion characteristics of dust clouds-Part 3: Determination of the lower explosion limit LEL of dust clouds.- European draft standard (February 2004) (Probably several of these standards are no longer drafts) We have used a highly recognised test-laboratory where they have been working with dust	IPPIC

Response	*Industry*
explosions for many years. • No individual testing of dusts, we rely on historical data. • Some years ago the German paint association VdL received indications that very small particles from recycled powders carried the potential for dust explosions. In 2005 a test was commissioned at a test institute in Freiberg. The results show that the fraction of very fine particles in a powder coating does indeed increase during the process of recycling by filter technologies, and that these "fine-enriched" powder wastes show a greater tendency towards explosion. A report is available in German (see embedded document. An English version is understood to exist but it is not at our disposal right now.)  VdL Bericht über die Bestimmung der Mind USA reply: • Some of our members utilize the 20 litre sphere determination.	
MIT and MIE (as referred to in previous answer above) are used as measures of sensitivity to ignition. We also carry out 20 litre sphere tests on Pmax and Kst, when we are looking at venting, suppression or containment as a basis of safety. We measure LOC in the 20 litre sphere when inerting might be used as the basis of safety. Other tests are layer tests for electrical area classification (T5mm), UN transport tests, thermal stability tests for safety in drying etc.	Syngenta

6. Do you have any dusts that you assume to be explosible or that present an explosion hazard, and, thus, preclude the need or expense of testing? If so, please indicate what type of dust

Response	*Industry*
There may not need to be a full range of testing, if a good understanding of the material and its use are known and documented.	The Dow Chemical Company
ACC is not aware of materials that are assumed to be combustible dust and as a result, require no additional testing. Systematic risk assessment protocols and determination of protection criteria require collection/use of physical data.	ACC
European reply: • Several powder coating products and raw materials are assumed to present an explosion hazard. The products are polyester, epoxy- or polyurethane-based powder paints for thermosetting industrial applications. Some of our powdered raw materials also represent an explosion-risk. • We assume all our powder coatings are explosible • Inorganic dusts (except aluminium and other metal powders) are non-combustible and therefore non-explosive. All organic dusts are explosive - the important points are: (i) knowing the explosion pressure (Kst value) so that we can install the correct mitigating	IPPIC

Response	*Industry*
controls (i.e. sizing of explosion relief panels); (ii) knowing the layer ignition temperature so that we can specify equipment correctly. USA reply: • Aluminum pastes: no matter how these are used there are always some amounts of dusts generated which must be addressed and controlled. As stated above, many of our members treat ALL dusts as potentially combustible. The industry uses large quantities of titanium dioxide pigment that is NOT a combustible dust. However, since it is used throughout many of the processes and mixed with combustible dusts, we do not treat it any differently than our known combustible dusts. The only dusts we treat differently are the combustible metal powders we use (mainly aluminum) that we use in accordance with NFPA 484.	
Most of our dusts can be flammable, so we can just assume that a dust is flammable. However, safety precautions depend much more on the other properties associated with sensitivity to ignition so we test materials to gather these parameters anyway. Theoretically we could save on this testing by taking a conservative set of assumptions, but those assumptions and the entailing precautions would probably cost us much more than carrying out a testing regime. Taking a conservative set of assumptions at early stage development of products, before we can get hold of sufficient sample to carry out testing, is however a reasonable and often necessary approach.	Syngenta

C. Hazard communication

7. Do you use SDSs to list mitigation measures? If so, please identify the information you provide

Response	*Industry*
As a global chemical company the Dow Chemical Material Safety Data Sheets (SDS) comply with appropriate country and legal codes and regulations. Dow also uses the NFPA 704 emergency ratings for many countries. NFPA 704 addresses combustible dusts as follows: i. Degree of Flammability Hazard 1 includes finely divided solids less than 420 m that are nonexplosible in air at ambient conditions, such as low volatile carbon black and polyvinylchloride (PVC). ii. Degree of Flammability Hazard 2 includes finely divided solids less than 420 m (40 mesh) that present an ordinary risk of forming an ignitible dust cloud. iii. Degree of Flammability Hazard 3 includes finely divided solids, typically less than 75 micrometers (m) (200 mesh), that present an elevated risk of forming an ignitible dust cloud, such as finely divided sulfur, National Electrical Code Group E dusts (e.g., aluminum, zirconium, and titanium), and bis-phenol A.	The Dow Chemical Company
Because the conditions under which a customer may use a product are varied and cannot be predicted by the manufacturer, no additional information can be provided on the SDS beyond stating that the material as shipped has the potential to explode under certain conditions.	ACC

Response	*Industry*
European reply: • Yes. The following text is incorporated in SDSs for powder coatings: In Section 5: Fire-fighting measures "Fire/explosion hazards: Fine dust clouds may form explosive mixtures with air." Section 6: Accidental release measures "Personal precautions: Exclude sources of ignition and ventilate the area. Avoid breathing dust. Refer to protective measures listed in sections 7 and 8. Spill : Contain and collect spillage with an electrically protected vacuum cleaner or by wet brushing and place in container for disposal according to local regulations (see section 13). Do not use a dry brush as dust clouds or static can be created." Section 7: Handling and storage "Handling Precautions should be taken to prevent the formation of dust in concentrations above flammable, explosive or occupational exposure limits. Electrical equipment and lighting should be protected to appropriate standards to prevent dust coming into contact with hot surfaces, sparks or ignition sources. Preparation may charge electrostatically: always use earthing leads when transferring from one container to another. Operators should wear anti-static footwear and clothing and floors should be of conducting type. Avoid skin and eye contact. Avoid the inhalation of dust, particulates and spray mist arising from the application of this preparation. Treatments such as sanding, welding, burning off etc. of paint films may generate hazardous dust and/or fumes. Work in well ventilated areas. Use suitable personal (respiratory) protective equipment, as necessary. Keep containers tightly closed. Isolate from sources of heat, sparks and open flame. Smoking, eating and drinking should be forbidden in application area. Comply with health and safety at work laws. Always keep in containers made of same material as the original one. For personal protection see section 8. Storage Observe label precautions. Store in a dry well-ventilated place away from sources of heat, ignition and direct sunlight. No smoking. Prevent unauthorised access. Containers that are opened must be carefully resealed and kept upright to prevent leakage." USA reply: • Our product (dust) MSDSs generally identify the products as combustible dusts (where applicable) but do not generally provide specific properties beyond that. Some, however, do provide specific data and mitigation procedures.	IPPIC
Safety data sheets should probably identify that there is a risk of dust explosions if the material is dispersed in air i.e. a dust cloud is formed. A safety data sheet cannot hope to list all possible mitigation measures	Syngenta

8. If appropriate, what information is placed on labels to identify the possibility of a dust explosion hazard?

Response	*Industry*
The information placed on labels varies with the country of shipment and the requirements for shipping as directed by local codes, standards and regulations.	The Dow Chemical Company
Chemicals in dust form are not inherently hazardous (it is an extrinsic, use-specific property) and most products are not shipped in dust form. This is a processing issue and not a product hazard. If a chemical is shipped in a dust form, the SDS should state whether the material as shipped has the potential to explode under certain conditions. The product should not be classified as hazardous under OSHA or require a label. Because the conditions under which a customer may use the product are varied and cannot be predicted by the manufacturer, no additional information can be provided on the SDS. The physical form, as shipped, is most important with regard to SDS statements as almost any carbon-containing or metal-containing solid could be combustible dusts if processed to small enough particle size.	ACC
European reply: • No information on possible explosion hazards is mentioned on labels USA reply: • The ACA Industry Labeling Guide , 5th Edition, addresses hazards such as these. The Guide has a sample label for "Powdered Coatings" which addresses the hazards of combustible dusts in both warning phrases and precautionary statements.	IPPIC
Safety data sheets contain information about a possible dust explosion hazard.	Syngenta

9. Do you use SDSs to communicate the hazards associated with dust explosions?

Response	*Industry*
Material Safety Data sheets often contain important warning information regarding dust materials. However the SDS are only used as a quick summary, and we supplement that information with appropriate training to address material hazards.	The Dow Chemical Company
For a chemical in a dust form, the SDS should state whether the material has the potential to explode under certain conditions.	ACC
European reply: • We use the information provided from raw material SDS and labels as one information source for our risk assessments and to communicate product specific hazards to our employees. USA reply: • The MSDSs received from our suppliers for raw materials generally do not provide sufficient information on combustibility or additional specific related information.	IPPIC
Safety data sheets should probably identify that there is a risk of dust explosions if the material is dispersed in air i.e. a dust cloud is formed.	Syngenta

10. How is information on the hazards of, and controls for, dust explosions communicated to workers?

Response	*Industry*
a. Communications of potential dust fire and explosion hazards are summarized in our SDS section on Fire Fighting Measures in a special section dealing with 'Unusual Fire and Explosion Hazards'. Within this section, dust material specific warnings, such as potential for dust to be ignited by static discharge, exposure of dust layers to elevated temperatures, deflagration temperatures, and perhaps even grinding, shock or friction warnings may be provided. An additional section dealing with Handling and Storage would often contain more specific controls. However the information in the SDS is only a summary input of importance and it is not a comprehensive discussion of all dust potential hazards nor does it address options for which proper mitigations may be used. b. However, details on the hazards of dusts and other chemicals are addressed with specific training on the materials being used. Such training includes but is not limited to information as appropriate on static electricity, potential ignition sources, importance of good housekeeping, maintenance of process equipment, attention to process information and instructions, material handling and disposal, emergency response procedures, and use of appropriate PPE.	The Dow Chemical Company
In the United States, companies comply with the Hazard Communication Standard (HCS) in 1910.1200 and conduct HCS training.	ACC
European reply: • At regular intervals and as part of new workers' training we have a program containing information on how to avoid creation of dust ("make calm movements") and avoid anything that can cause ignition. Risk assessments have been conducted with testing of products and raw materials and this has been communicated to all workers. The training has been carried out as part of continuous education and has to be repeated. • Communicated in standard operating procedures and trained at least annually. • Through training and safe operating procedures – especially relevant to dust collection arrangements of extraction equipment – in general, we believe that this is the only situation where an explosible concentration of dust may be present (to cause a primary explosion). USA reply: • Employees are trained and they receive refresher training. Most of our members conduct annual training, though not required, and definitely re-training when the hazards associated with the product changes. Our industry generally conducts testing, interviews, classroom discussions, and site observations as part of an overall facility process to evaluate employee comprehension and application.	IPPIC
Plant instruction sheets ultimately cover safety aspects of materials handled. This information is identified during risk assessments, and risk assessments information should be translated into precautions and actions to take during operation. It is normal to deliver specific training to operators on the hazards of the materials that they are handling. In some cases additional training can be given by the expert group including laboratory demonstrations and videos of materials burning or being ignited. Many operators find the falling door demonstration particularly powerful (disturbing a dust layer which then ignites) – more so than many years of nags and requests for good housekeeping.	Syngenta

D. Standards

11. What standards or guides do you use to address explosible dusts in any manner (definition, testing, hazard recognition, hazard assessment, hazard communication, mitigation methods, emergency response, investigation, etc.)? Indicate if they are used throughout your industry. Please provide a copy (in English, if possible)

Response	*Industry*
As mentioned above we use a number of the ASTM and other recognized IEC testing procedures.	The Dow Chemical Company
The fundamental guiding document in use in the United States is NFPA 654, while ancillary standards and procedures referenced in this document provide specific guidance on related topics (e.g., vent sizing). In addition, OSHA 1910.307 for electrical classification is also used.	ACC
European reply: • We follow ATEX (European Directive 94/9/EC) – and have an ATEX certificate. Our production is in ATEX-compliance. Besides this, ISO 9001, ISO 14001 and OHSAS 18001 are standards in use over several years and demand continuous improvement in quality etc. ATEX and the other standards are widely in use throughout the Powder Coatings industry. • A common standard is provided by European ATEX directive and relevant national regulations, plus the associated technical guidelines and the CEPE safe powder coating guidelines. • Internal standards and guidance based on published literature and proprietary information gained from studies with competent third parties. USA reply: • Our industry generally follows the provisions in NFPA standards for combustible dust. Additionally they generally use the standards referenced in the OSHA Hazard Communication Guidance for Combustible Dusts. Not all in totality as we comply with specific standards and sections of those standards as applicable to each facility process. Some in the industry use FM Global Property Loss Prevention Data Sheet 7-76, Prevention and Mitigation of Combustible Dust Explosions and Fires, as an aid in determining how to mitigate the hazards of combustible dust. The Data Sheet has been reviewed by many of our members (FM has made their previously private documents available to everyone) but does not contain any additional information other then what we have from other sources. Another guidance for combustible dusts used by our industry is ACA's "Generation and Control of Static Electricity in Coatings Operations". This document can be made available upon request. Additionally, some members use corporate guidelines and some use insurance carrier recommendations.	IPPIC
Explosible Dusts come under DSEAR (Dangerous Substances and Explosive Atmospheres Regulations - http://www.opsi.gov.uk/si/si2002/20022776.htm). This is the UK implementation of ATEX. There is guidance from the HSE (http://www.hse.gov.uk/fireandexplosion/dsear.htm) Standards: BSI BS EN 13821 Potentially explosive atmospheres: Explosion prevention and protection- Determination of minimum ignition energy of dust/air mixtures EN 14034-1:2004 Determination of explosion characteristics of dust clouds. Determination of the maximum explosion pressure pmax of dust clouds EN 14034-2:2006 Determination of explosion characteristics of dust clouds. Determination of	Syngenta

Response	*Industry*
the maximum rate of explosion pressure rise (dp/dt) max of dust clouds EN 14034-3:2006 Determination of explosion characteristics of dust clouds. Determination of the lower explosion limit LEL of dust clouds EN 14034-4:2004 Determination of explosion characteristics of dust clouds. Determination of the limiting oxygen concentration LOC of dust clouds	

12. Concerning those you do business with (businesses in other countries, provinces, etc.), what conflicts have you experienced while addressing dust hazards? Please explain how you resolved the conflicts.

Response	*Industry*
Within recent years many of the 'conflicts' we have encountered with dust hazards have more to do with the ever changing definitions of what is a combustible dust. For our products we have been able to resolve these issues by use of our historical practices of extensive evaluation and identification of the potential hazards dust products may have. When we find we do not have the needed data to support a position, we conduct what we consider to be appropriate testing methods so that our processing can be done in a safe manner with properly designed processing equipment.	The Dow Chemical Company
Conflicts can exist depending on what requirements need to be followed. For example requirements differ between performance standards and ATEX, with the latter typically being more costly, but not necessarily providing better protection.	ACC
European reply: • The explosion hazard connected to powder coatings is widely known in the industry. We have not encountered any conflicts with those we do business with. We sell our products in both Europe and in many industrialized countries in Asia and Europe and Australia. • Some customers are expecting different or more exact (product specific/ no ranges) explosivity data provided in the SDS. We try to provide further information on customer request. • Lack of data available from suppliers of raw materials – this applies globally. Where data is provided, this can clearly be inaccurate (for example, one set of data used for a range of organic pigments with significantly different chemistries). This remains an issue – we continue to assume the properties of most powders in order to proceed with risk assessments. Very few suppliers have responded to requests for more data. Note: We believe that resistivity of powders is an important issue – this indicates whether the powder is likely to create a static ignition source of sufficient energy to ignite a flammable vapour atmosphere. Our experience is that an explosion/fire with this root cause is far more likely when loading powders into flammable solvent (varnish manufacture) than a dust explosion (because the ignition energy for solvent vapour is significantly lower than the ignition energy for a dust cloud, even if the dust concentration was sufficiently high). This risk does not appear to be on the radar for resin manufacturers/suppliers or their trade association (ERMA) but it is one of the most significant and difficult to control risks for us. USA reply: • No inputs available.	IPPIC
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